

Chapter 1

Principles and Methods of Development Research

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Abstract

This chapter discusses the role of research in relation to educational design and development activities. The first part of the chapter focuses on the rationale and basic principles of development research by outlining motives for conducting formative research, analyzing definitions and aims of various types of development research, and discussing several of its key characteristics. The second part of the chapter deals with methods of development research, exploring some of its typical problems and dilemmas, and discussing several challenges for further action and reflection.

1. INTRODUCTION

This book offers a broad overview and many examples of design and development approaches and tools for education and training purposes. These texts share a common characteristic: they interpret education primarily as a 'design science', emphasizing its problem-oriented and interdisciplinary orientation. That perspective is also illustrated through the research approaches and methods chosen in many of those studies. Although 'Design & Development Research' would perhaps serve as a more adequate term to represent all intended research types, we have chosen the term 'Development Research' as an umbrella term, because it is shorter and also because the words 'design' and 'development' are often used interchangeably (see part I of this book).

Although research in relation to design and development issues is strongly emerging in various sub-domains of education, few efforts have yet been made to articulate its major principles and methods (the best exception being the well documented analysis by Richey and Nelson, 1996). It is the goal of this chapter to contribute to that discussion. The first part of the chapter (sections 2, 3, and 4) will focus on the rationale and basic principles of development research by: outlining motives for conducting development research, analyzing definitions and aims of various types of development research, and discussing several of its key characteristics. The second part of the chapter (sections 5 and 6) will focus on methods of development research, exploring its

typical problems and dilemmas, and discussing several challenges for further action and reflection.

2. MOTIVES FOR DEVELOPMENT RESEARCH

Various motives for initiating and conducting development research can be mentioned. A basic motive stems from the experience that 'traditional' research approaches (e.g. experiments, surveys, correlational analyses), with their focus on descriptive knowledge, hardly provide prescriptions with useful solutions for a variety of design and development problems in education. Probably the greatest challenge for professional designers is how to cope with the manifold uncertainties in their complex tasks in very dynamic contexts. If they do seek support from research to reduce those uncertainties, several frustrations often arise: answers are too narrow to be meaningful, too superficial to be instrumental, too artificial to be relevant, and, on top of that, they usually come too late to be of any use. Designers do appreciate more adequate information to create a solid ground for their choices and more timely feedback to improve their products. Moreover, the professional community of developers as a whole would be helped by a growing body of knowledge of theoretically underpinned and empirically tested design principles and methods.

Another reason for development research stems from the highly ambitious and complex nature of many reform policies in education worldwide. These reform endeavors usually affect many system components, are often multi-layered, including both large-scale policies and small-scale realization, and are very comprehensive in terms of factors included and people involved. Those radical 'revolutions', if promising at all, cannot be realized on the drawing table. The scope of diverse needs is often very wide, the problems to be addressed are usually ill-specified, the effectiveness of proposed interventions is mostly unknown beforehand, and the eventual success is highly dependent on implementation processes in a broad variety of contexts. Therefore, such reform efforts would profit from more evolutionary (interactive, cyclic, spiral) approaches, with integrated research activities to feed the process (both forward and backward). Such an approach would provide more opportunities for 'successive approximation' of the ideals and for more strategic learning in general. Especially those endeavors that aim at exploring and exploiting the potential of information and communication technologies in education (see the many examples in this book), are very much in need of research to overcome their inherent complexities. Policy makers rarely commission such research, at least compared to investments for development itself. Such negligence may not only be caused by naïveté (underestimating the need for clarification of the task and for empirical feedback) or frugality, but also by the still hazy image of development research. Its characteristics and added value demand better theoretical articulation, more empirical evidence, wider application in development practices, and a more prominent place in professional and scientific publications.

A motive also worth mentioning here, refers to the rather dubious reputation of educational research in general. Not only does one hear complaints about the lack of relevance of educational research from policy makers and practitioners, also many researchers themselves share that opinion (although usually with somewhat other nuances in their wording of the problem). They strive after more direct contributions to educational improvement processes with a noticeable impact. Moreover, more direct

interaction with practice might offer them valuable incentives for sharpening their theoretical insights and transforming their descriptive knowledge in design principles. Thus, last but not least, there is also a distinct scientific interest at stake.

3. DEFINITIONS AND AIMS OF DEVELOPMENT RESEARCH

3.1 Conceptual confusion

Thusfar in this chapter the Development Research label has been used to refer to various kinds of research approaches that are related to design and development work. In the literature one comes across many different, more specific labels for such research. A (not exhaustive) list:

- *Design* studies; *Design* experiments; *Design* research;
- *Development/Developmental* research;
- *Formative* research; *Formative* inquiry; *Formative* experiments; *Formative* evaluation;
- *Action* research;
- *Engineering* research.

The situation is rather confusing. Some of these terms, such as 'action research' or 'formative evaluation', have longer roots in literature and professional practice, most others are of more recent date. Some labels seem related to specific sub-domains of education (e.g. action research was predominantly used in the area of Teacher Education, and formative evaluation in the areas of Curriculum and Instructional Development) but they become also fashionable in other areas (e.g. 'action research' in the area of learning and instruction). Also, 'new' terms (such as 'design experiments') come to the surface. Clearly, we are dealing with an emerging trend, characterized by a proliferation of terminology and a lack of consensus on definitions.

Of course, we do not aspire to solve these conceptual puzzles here for once and for all. However, in order to create a basis for later discussion on methodological issues, we need to establish a basic structure. As a starting point, we will explore the use of these concepts in different sub-domains of education.

3.2 Development research in different sub-domains

Ideas about the role of development research appear to differ among various sub-domains. Let us take a closer look at a selection of areas where these ideas are practiced and discussed.

- *Curriculum*

In discussing methodological issues in curriculum research, Walker has used various related terms, such as 'formative research' (Walker, 1992) and 'development research' (Walker & Bresler, 1993). The major goal of such research is to inform the decision making process during the development of a product/program in order to improve the product/program being developed and the developers' capabilities to create things of this

kind in future situations. The emphasis in his writings is on the supportive role of research for development.

Comparable proposals have been formulated by van den Akker and Plomp (1993) who defined 'development research' by its twofold purpose: (i) supporting the development of prototypical products (including providing empirical evidence for their effectiveness), and (ii) generating methodological directions for the design and evaluation of such products. In this approach, the scientific contribution (knowledge growth) is seen as equally important as the practical contribution (product improvement). In recent years these ideas have been exemplified in a number of doctoral dissertations at the University of Twente, in a variety of curricular contexts, such as: Voogt (1993) and Keursten (1994) in the area of courseware development for various school subjects; Kessels (1993), focusing on design standards in the context of corporate education; van den Berg (1996) and Roes (1997) addressing scenarios for teacher in-service education; Nieveen (1997), exploring the potential of computer support for curriculum developers; Visser (1998) on communication support tools in distance education; and Thijs (1999) on teacher development in developing countries.

- *Media & Technology*

In the rapidly growing area of educational media and technology, development research has a prominent place. For example, Flagg (1990) underlined the role of formative evaluation for (media) program improvement and offered a number of exemplary studies. Richey and Nelson (1996) have provided the most comprehensive overview and analysis of 'developmental research' in the sub-domain of educational technology so far. They mention as its ultimate aim: "improving the processes of instructional design, development, and evaluation ... based on either situation-specific problem solving or generalized inquiry procedures" (o.c., p. 1213). They make a clear distinction between performing a process and studying that process. In the latter instance, these studies often have a reconstructive nature.

- *Learning & Instruction*

Also in the broad sub-domain of learning and instruction, pleas for development research are increasingly made. Referring to earlier proposals of Brown (1992) and Collins (1992) to invest more in 'design experiments', Greeno, Collins and Resnick (1996) underline a significant shift in the relationship between theoretical and practical work in educational psychology. They highlight the "kind of research that includes developmental work in designing learning environments, formulating curricula, and assessing achievements of cognition and learning and, simultaneously, on efforts to contribute to fundamental scientific understanding" (o.c., p. 41). Researchers should not only concentrate on the question of whether a theory yields coherent and accurate predictions, but also ask whether it works: do the theoretical concepts and principles inform practices in productive ways. In the same vein, Reigeluth and Frick (1999) argue for 'formative research', referred to as "a kind of developmental or action research that is intended to improve design theory for designing instructional practices or processes" (o.c., p. 633).

- *Teacher Education & Didactics*

Two related sub-domains where types of development research are already relatively well-established are teacher education (encompassing both pre- and in-service education

as well as the broader phenomenon of professional development) and didactics (especially linked to several school subjects). In the teacher education area the concept of 'action research' is rather popular. It refers to practical inquiries where teachers (often in collaboration with others) investigate and reflect on their own teaching and students' learning. The primary goal is usually to contribute to the teachers' professional learning and/or bringing about change in a specific educational setting (Elliott, 1991; Hollingsworth, 1997). In the area of didactics the emphasis tends to be on 'developmental research' as an interactive, cyclic process of development and research in which theoretical ideas of the designer feed the development of products that are tested in classroom settings, eventually leading to theoretically and empirically founded products, learning processes of the developers, and (local) instructional theories (see e.g. Gravemeijer, 1994, for the mathematics domain, and Lijnse, 1995, for the science domain).

The four sub-domains mentioned above (all of them often related to product/program development, in one way or another) show the most visible and increasing role of development research in education (and also illustrate the conceptual confusion). Of course, there may also be examples in other sub-domains, but they often do not (yet) represent a strong trend in research approaches in those areas. Also, there are exemplary studies that very well reflect development research approaches but that can not easily be classified under a certain sub-domain. For example, the work in the Jasper Project of the Cognition and Technology Group at Vanderbilt (1997) is most remarkable as it reflects a broad range of sophisticated research procedures in various stages and on various aspects of that project, thus contributing to nearly all kinds of (previously mentioned) aims.

3.3 A typology of development research activities

The previous section revealed that one can distinguish a broad variety of activities, with different emphases in their primary aims, under the main umbrella of development research. Also, on a rather abstract level, one can distill a very general aim of all approaches: reducing uncertainty of decision making in designing and developing (educational) interventions. The term 'intervention' then serves as common denominator for products, programs, materials, procedures, scenarios, processes, and the like. That general aim can be specified in two more specific goals that apply to those approaches in various degrees: (a) providing ideas (suggestions, directions) for optimizing the quality of the intervention to be developed; (b) generating, articulating and testing design principles. These principles can be of a 'substantive' nature, referring to characteristics of the intervention (what it should look like), or of a 'procedural' nature (how it should be developed).

The goals differ in their relative contribution to 'practice' and 'science'. While the first one (optimization of intervention) is especially oriented towards practical ends in a given situation, the last aim (design principles) more strongly reflects scientific or scholarly aspirations, since it is more explicitly oriented towards production of knowledge of a generalizable nature.

An additional objective is also visible in various approaches: stimulating professional development of participants. This motive even appears to be in the forefront of many 'action research' activities.

However, in an effort to structure various types of development research, we find it difficult to include action research in our framework. First, because it is a rather volatile term that has known changing connotations over the last decades in various contexts (see Hollingsworth, 1997). Second, because in practice it often refers to activities that almost exclusively convey the 'action' component and lack an explicit scholarly orientation on contributions to knowledge that is accessible to others. In our view, an approach which is to be subsumed under the heading of development research must possess more balance between development and research.

Another way to differentiate between various types of development research is to focus on the temporal relation between design and development activities on one hand, and the research activities on the other: Is the research concentrated in the stages before, during, or after the bulk of design and development activities? Most of the examples mentioned thus far focused on activities that occur either before actual design (explorative studies to analyze problems-in-context and to screen related examples of interventions in order to generate design ideas) or throughout the entire, cyclic development work (in order to offer suggestions for improvement and to test design principles). In these processes the personal linkage between those who conduct the design and development activities and those who perform the research is usually strong. In their overview of 'developmental research' Richey and Nelson (1996) distinguish between 'type I' and 'type II' approaches. Type I refers to an approach in which the roles of designer and researcher (partly) coincide within a specific development context. Such research usually occurs throughout the complete development cycle. In type II, however, that relationship is more loose: the researchers are not involved in the design and development process themselves, but they study those processes (including tools and models applied) as practiced by others, in order to come to conclusions concerning design principles of generalizable nature. The emphasis in timing of those reconstructive activities is during, but especially after those design and development practices.

We prefer a somewhat more meaningful labeling of the various approaches. A first approach worth mentioning is: *Explorative Design Studies*. These activities, preceding the actual development work, aim at clarifying the design problem-in-context and at generating tentative design ideas. Such explorations can be very valuable in directing the development work. However, we tend not to include these studies under the heading of 'scientific' research, because they do not aim at statements of a more or less generalizable nature. That intention is very apparent in the two main types of development research:

- *Formative Research*. Research activities performed during the entire development process of a specific intervention, from exploratory studies through (formative and summative) evaluation studies; aimed at optimization of the quality of the intervention as well as testing design principles.
- *Reconstructive Studies*. Research activities conducted sometimes during, but oftentimes after the development process of several interventions; focused on the articulation and specification of design principles

Obviously, this typology does not pay justice to many possible differences and linkages between various sorts of development research. The boundaries and labels are not very strict (for example, exploratory design studies often convert to formative research) but they do make a distinction between approaches with relatively different

emphases. The typology offers a useful starting point for more detailed and nuanced discussions on characteristics and methods of development research in the remaining part of this chapter.

4. KEY CHARACTERISTICS OF DEVELOPMENT RESEARCH

We will try to delineate the key characteristics of development research by exploring two questions:

- (i) What are differences between development research - as a research endeavor - and typical design and development approaches in professional practices?
- (ii) In what respect does development research differ from other research approaches?

The next two sections will address these questions.

4.1 Differences between development research and professional design and development

Development research is often initiated for complex, innovative tasks for which only very few validated principles are available to structure and support the design and development activities. Since in those situations the image and impact of the intervention to be developed is often still unclear, the research focuses on realizing limited but promising examples of those interventions. The aim is not to elaborate and implement complete interventions, but to come to (successive) prototypes that increasingly meet the innovative aspirations and requirements. The process is often cyclic or spiral: analysis, design, evaluation and revision activities are iterated until a satisfying balance between ideals and realization has been achieved.

To what extent do these development research activities differ from what is typical for design and development approaches in professional practices? What are the implications of the accountability of researchers to the 'scientific forum'? At the risk of exaggerating the differences, let us outline some of them, based on what is known about routinized standard-patterns in professional contexts. Of course, a lot of activities are more or less common for both approaches, so the focus will be on those additional elements that are more prominent in development research than in common design and development practices.

(1) Preliminary investigation

A more intensive and systematic preliminary investigation of tasks, problems, and context is made, including searching for more accurate and explicit connections of that analysis with state-of-the-art knowledge from literature. Some typical activities include: literature review; consultation of experts; analysis of available promising examples for related purposes; case studies of current practices to specify and better understand needs and problems in intended user contexts.

(2) Theoretical embedding

More systematic efforts are made to apply state-of-the-art knowledge in articulating the theoretical rationale for design choices. Moreover, explicit feedback to assertions in the design rationale about essential characteristics of the intervention (substantive design principles) are made after empirical testing of its quality. This theoretical articulation can increase the 'transparency' and 'plausibility' of the rationale. Because of their specific focus, these theoretical notions are usually referred to as 'mini'- or 'local' theories, although sometimes connections can also be made to 'middle-range' theories with a somewhat broader scope.

(3) Empirical testing

Clear empirical evidence is delivered about the practicality and effectiveness of the intervention for the intended target group in real user settings. In view of the wide variation of possible interventions and contexts, a broad range of (direct/indirect; intermediate/ultimate) indicators for 'success' should be considered.

(4) Documentation, analysis and reflection on process and outcomes

Much attention is paid to systematic documentation, analysis and reflection on the entire design, development, evaluation and implementation process and on its outcomes in order to contribute to the expansion and specification of the methodology of design and development.

Relating this outline to the differentiation in various types of development research in section 3.3, it seems that all of them have been touched upon. In reality, the emphasis will differ. Formative research is the most comprehensive type of development research, including all of the components mentioned above, but concentrating on theoretical embedding and empirical testing. The label of exploratory design studies is in place when the emphasis is on preliminary investigation, while reconstructive studies focus on documentation, analysis and reflection.

4.2 Development research compared to other research approaches

Differences between development research and other research approaches are best perceived from their different aims and context. We will explore some of these features below.

Successive approximation of interventions in interaction with practitioners

More than most other research approaches, development research aims at making both practical and scientific contributions. In the search for innovative 'solutions' for educational problems, interaction with practitioners (in various professional roles: teachers, policy makers, developers, and the like) is essential. The ultimate aim is not to test whether theory, when applied to practice, is a good predictor of events. The interrelation between theory and practice is more complex and dynamic: is it possible to create a practical and effective intervention for an existing problem or intended change in the real world? The innovative challenge is usually quite substantial, otherwise the research would not be initiated at all. Interaction with practitioners is needed to gradually clarify both the problem at stake and the characteristics of its potential solution. An iterative process of 'successive approximation' or 'evolutionary

prototyping' of the 'ideal' intervention is desirable. Direct application of theory is not sufficient to solve those complicated problems. One might state that a more 'constructivist' development approach is preferable: researchers and practitioners cooperatively construct workable interventions and articulate principles that underpin the effects of those interventions.

Another reason for cooperation is that without involvement of practitioners it is impossible to gain clear insight in potential implementation problems and to generate measures to reduce those problems. New interventions, however imaginative their design, require continuous anticipation at implementation issues. Not only for 'social' reasons (to build commitment and ownership of users) but also for 'technical' benefits: to improve their fitness for survival in real life contexts. Therefore, rigorous testing of practicality is a *conditio sine qua non* in development research.

Nature of knowledge from development research

A couple of remarks are to be made about the knowledge claims based on development research.

The major knowledge to be gained from development research is in the form of (both substantive and methodological) '**design principles**' to support designers in their task. Those principles are usually heuristic statements of a format such as: "**If you want to design intervention X [for the purpose/function Y in context Z], then you are best advised to give that intervention the characteristics A, B, and C [substantive emphasis], and to do that via procedures K, L, and M [procedural emphasis], because of arguments P, Q, and R.**"

Obviously those principles cannot guarantee success, but they are intended to select and apply the most appropriate (substantive and procedural) knowledge for specific design and development tasks.

It is not uncommon in formative research that such knowledge, especially the substantive knowledge about essential characteristics of an intervention, can partly be extracted from a resulting prototype itself. That is one of the reasons that makes it so profitable to search for and carefully analyze already available interventions to generate ideas for new design tasks (something easier to be done, of course, when the intervention is a concrete product than a more process-oriented scenario). However, the value of that knowledge will strongly increase when justified by theoretical arguments, well-articulated in providing directions, and convincingly backed-up with empirical evidence about the impact of those principles. Moreover, those heuristic principles will be additionally powerful if they have been validated in successful design of more interventions in more contexts. Chances for such knowledge growth will increase when development research is conducted in the framework of research programs, because projects can then build upon one another.

5. METHODS OF DEVELOPMENT RESEARCH

Methods of development research are not necessarily different from those in other research approaches. However, there are some specific features that are worth discussing here to further clarify the image of development research. The first one has to do with the central role of formative evaluation procedures in formative research.

The second aspect refers to several typical methodological problems and dilemmas for development researchers.

5.1 Formative evaluation as key activity

As has become clear in the previous sections, formative evaluation holds a prominent place in development research, especially in formative research. The main reason for this central role is that formative evaluation provides the information that feeds the cyclic learning process of developers during the subsequent loops of a design and development trajectory. It is most useful when fully integrated in a cycle of analysis, design, evaluation, revision, et cetera, and when contributing to improvement of the intervention.

It is hardly useful to summarize here the major methods and techniques of formative evaluation in relation to development work. Many adequate sources are already available, e.g. Brinkerhoff et al. (1983), Flagg (1990), Herman (1987), Tessmer (1993), Thiagarajan (1991); see also Nieveen (1997) for a synopsis. However, a few typical characteristics of formative evaluation within the context of development research approaches deserve some elaboration.

Priority on information richness and efficiency

Formative evaluation within development research should not only concentrate on locating shortcomings of the intervention in its current (draft) version, but especially generate suggestions in how to improve those weak points. Richness of information, notably salience and meaningfulness of suggestions in how to make an intervention stronger, is therefore more productive than standardization of methods to collect and analyze data. Also, efficiency of procedures is crucial. The lower the costs in time and energy for data collection, processing, analysis and communication, the bigger the chances on actual use and impact on the development process. For example, samples of respondents and situations for data collection will usually be relatively small and purposive compared to sampling procedures for other research purposes. The added value of getting 'productive' information from more sources tends to decrease, because the opportunities for 'rich' data collection methods (such as interviews and observations) are limited with big numbers. To avoid an overdose of uncertainty in data interpretation, often triangulation (of methods, instruments, sources, and sites) is applied. These arguments especially hold true for early stages of formative evaluation, when the intervention is still poorly crystallized.

Shifting emphasis in quality criteria

The basic contribution of formative evaluation is to quality improvement of the intervention under development. Quality, however, is an abstract concept that requires specification. During development processes, the emphasis in criteria for quality usually shifts from validity, to practicality, to effectiveness (cf. Nieveen's chapter 10 in this book). Validity refers to the extent that the design of the intervention is based on state-of-the-art knowledge ('content validity') and that the various components of the intervention are consistently linked to each other ('construct validity'). Practicality refers to the extent that users (and other experts) consider the intervention as appealing and usable in 'normal' conditions. Effectiveness refers to the extent that the experiences and outcomes with the intervention are consistent with the intended aims.

The methods and techniques for evaluation will usually be attuned to that shift in criteria. For example, validity can adequately be evaluated through expert appraisal, practicality via micro-evaluations and try-outs, and effectiveness in field tests. In later stages of formative evaluation, methods of data collection will usually be less intensive but with an increasing number of respondents (e.g. achievement test for many students compared to in-depth interview with a few experts).

5.2 Problems and dilemmas in development research

What are some typical problems and dilemmas faced by researchers engaging in development research? Let us briefly explore some of them, notably as often experienced in formative research, where the combination of practical and scientific aims is most prominent.

Tension in role division between development and research

An often expressed problem in formative research is the tension in the division of roles between developers and researchers. Although that problem can be minimized when working in bigger teams in which some role variation is possible, a tension can easily arise between designers who are eager to pursue their ideals in creating innovative interventions on the one hand, and researchers who tend to critically seek for correctness of decisions and empirical proof of outcomes, on the other hand. Such controversy between 'subjective and imaginative involvement' and 'objective and critical distance' is not necessarily negative. It can also be treated as a productive force that contributes to balanced solutions. As a rule of thumb, one might stipulate that in early stages of formative research, progress is helped by a dominance of the creative designers' perspective, while at later stages a shift to a stronger voice for the more critical researchers' position is preferable.

Isolating 'critical' variables versus comprehensive and complex design

A typical difference between formative research and many other sorts of research is that one can hardly isolate, manipulate and measure separate variables in the same study. On the contrary, it is the very nature of formative research to investigate comprehensive interventions that deal with many interrelated elements at the same time. That makes it very hard to apply, for example, experimental approaches. Although that limitation is disappointing to some researchers, it should not be of great concern to formative researchers. The aim of formative research is different, as already extensively argued, and that requires other, more comprehensive and flexible approaches that offer less strict methodological precision, but more adequate answers to design problems. Otherwise, it should be noted that experimental approaches are not entirely impossible in the context of development research. Especially if the design aims toward instructional interventions, summative evaluation via experimental methods may be appropriate and feasible at the end of the trajectory, when it makes sense to measure the effectiveness of 'mature' interventions with larger numbers of students. For that matter, it is not surprising that educational psychologists in particular like to speak about 'design experiments'.

The apparent lack of rigor and control in methodology of development research is sometimes aggravated by unforeseen events or forces in the environment of the

development task and context. Especially in long development trajectories of interventions that are easily susceptible to changes in external policies or organizational conditions, one may be forced to adapt research foci or procedures in the methodology approach initially chosen in order to address those changes (cf. Smith, 1993; Thijs, 1999).

Generalization of findings

Since data collection in formative research is usually limited to small (and purposive) samples, efforts to generalize findings cannot be based on statistical techniques, focusing on generalizations from sample to population. Instead one has to invest in 'analytical' forms of generalization: readers need to be supported to make their own attempts to explore the potential transfer of the research findings to theoretical propositions in relation to their own context. Reports on formative research can facilitate that task of analogy reasoning by a clear theoretical articulation of the design principles applied and by a careful description of both the evaluation procedures as well as the implementation context (Miles and Huberman, 1994; Yin, 1994). Especially a 'thick' description of the process-in-context may increase the 'ecological' validity of the findings, so that others can estimate in what respects and to what extent transfer from the reported situation to their own is possible. Another option that may stimulate exploration of possibilities for (virtual) generalization is to organize interactive meetings with experts from related contexts to discuss the plausibility of the research findings and recommendations for related tasks and contexts.

6. MAJOR CHALLENGES FOR DEVELOPMENT RESEARCH

As previously indicated, development research, as a relatively new and upcoming research approach, has its potentials and limitations. At the end of this chapter, it seems worthwhile to mention a few challenges for those who are interested in further exploration and improvement of its methodology.

For example, a challenging trend for designers is the increasing prominence of prototyping approaches (see the contributions of Moonen, and Nieveen in chapters 8 and 10 of this book). Various questions arise: What does (rapid/evolutionary) prototyping imply for efficiency of the development process? Will it affect the balance between creative and systematic features of the approach? Does it reduce the relevance of preliminary investigations? To what extent does it influence the relationship between methodology (as prescribed in literature) and actual design activities in professional practices (can 'theory' keep up with 'practice', or will the gap even widen)?

In relation to this trend: will the many emerging technological tools and environments for learning, communication, designing and performance support (see Part II of this book) strongly change development approaches and outcomes? Will they reduce the distance between design, delivery, and utilization of educational interventions?

Many challenges are also apparent with respect to evaluation methodology. What are appropriate tactics for increasing the information richness and efficiency of data

collection procedures and instruments? How may the linkages between data collection, processing, and analysis be optimized? How can the communication about evaluation findings and the subsequent utilization for improvement of interventions be furthered? What are the most relevant indicators of quality, success and impact of interventions? What are promising approaches to further the generalizability of research findings? How can the utilization of evaluation findings to design tasks in other settings be facilitated? Many useful suggestions and examples of such tactics are already offered in various publications (e.g. Miles and Huberman, 1994; Walker, 1992), but additional support is quite welcome.

An overall reflection is that research-based progress to expand and sharpen our knowledge on design and development is greatly enhanced through interdisciplinary approaches with purposive cross-fertilization between the many specialized sub-domains in educational science and technology. Moreover, it is our own experience that joint development research efforts of professionals in various roles offer fine opportunities for professional learning and capacity building. Such activities have the potential to sometimes produce outcomes with 'interocular' significance: results that hit you between the eyes (Scriven, 1996).

REFERENCES

- Brinkerhoff, R.O., Brethouwer, D.M., Hluchyi, T. and Nowakoski, J.R., 1983, *Program evaluation: A practitioner's guide for trainers and educators*, Kluwer-Nijhoff, Boston.
- Brown, A.L., 1992, Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings, *Journal of the Learning Sciences*, 2, 141-178
- Cognition and Technology Group at Vanderbilt, 1997, *The Jasper project: Lessons in curriculum, instruction, assessment, and professional development*, Lawrence Erlbaum Associates, Mahwah, NJ.
- Collins, A., 1992, Towards a design science of education, In Scanlon, E. and O'Shea, T. (Eds.), *New directions in educational technology* (pp.15-22). Springer, Berlin.
- Elliott, J., 1991, *Action research for educational change*, Open University Press, Milton Keynes.
- Flagg, B.N., 1990, *Formative evaluation for educational technologies*. Lawrence Erlbaum Associates, Hillsdale, NJ.
- Gravemeijer, K., 1994, *Developing realistic mathematics education*, Doctoral dissertation, Freudenthal Institute, Utrecht.
- Greeno, J.G., Collins, A. and Resnick, L., 1996, Cognition and learning, In Berliner, D.C. and Calfee, R.C. (Eds.), *Handbook of educational psychology* (pp. 15-46), Macmillan, New York.
- Herman, J.L. (Ed.), 1987, *Program evaluation kit*, Sage, Newbury Park, CA.
- Hollingsworth, S., 1997, *International action research: A casebook for educational reform*, Falmer Press, London.
- Kessels, J.W.M., 1993, *Towards design standards for curriculum consistency in corporate education*, Doctoral dissertation, University of Twente, Enschede.
- Keursten, P., 1994, *Courseware-ontwikkeling met het oog op implementatie: De docent centraal* [Courseware development from an implementation perspective: A central role for the teacher], Doctoral dissertation, University of Twente, Enschede.
- Lijnse, P., 1995, "Developmental research" as a way to empirically based "didactical structure" of science, *Science Education*, 79, 189-199.
- Miles, M.B. and Huberman, A.M., 1994, *Qualitative data analysis: An expanded sourcebook*, Sage, London.
- Moonen, J., 1996, Prototyping as a design method, In Plomp, T. and Ely, D.P. (Eds.), *International encyclopedia of educational technology* (pp. 186-190), Pergamon, Oxford.
- Nieveen, N.M., 1997, *Computer support for curriculum developers: A study on the potential of computer support in the domain of formative curriculum evaluation*, Doctoral dissertation, University of Twente, Enschede.

- Reigeluth, C.M. and Frick, Th.W., 1999, Formative research: A methodology for creating and improving design theories, In C. Reigeluth (Ed.), *Instructional-design theories and models. A new paradigm of instructional theory*, Volume II (pp. 633-651), Lawrence Erlbaum Associates, Mahwah, NJ.
- Richey, R.C. and Nelson, W.A., 1996, Developmental research, In D. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 1213-1245), Macmillan, London.
- Roes, M.A., 1997, Nascholing op basis van lesvoorbeelden in de context van curriculumvernieuwing [Inservice education based on exemplary lesson materials within the context of curriculum renewal], Doctoral dissertation, University of Twente, Enschede.
- Scriven, M., 1996, In Cooley, W., Gage, N. and Scriven, M., "The vision thing", Educational research and the AERA in the 21st century, Competing visions of what educational researchers should do, *Educational Researcher*, 26(4), 18-21.
- Smith, N.L., 1993, Flexibility in the evaluation of emergent programs, *Studies in Educational Evaluation*, 16, 209-229.
- Tessmer, M., 1993, *Planning and conducting formative evaluations: Improving the quality of education and training*, Kogan Page, London.
- Thijs, A., 1999, Supporting science curriculum reform in Botswana: The potential of peer coaching, Doctoral dissertation, University of Twente, Enschede.
- Thiagarajan, S., 1991, Formative evaluation in performance technology, *Performance Improvement Quarterly*, 4(2), 22-34.
- van den Akker, J. and Plomp, T., 1993, *Development research in curriculum: Propositions and experiences*, Paper presented at AERA meeting, April 12-16, Atlanta.
- van den Berg, E., 1996, *Effects of inservice education on implementation of elementary science*, Doctoral dissertation, University of Twente, Enschede.
- Visser, L., 1998, The development of motivational communication in distance education support, Doctoral dissertation, University of Twente, Enschede.
- Voogt, J.M., 1993, Courseware for an inquiry-based science curriculum: An implementation perspective, Doctoral dissertation, University of Twente, Enschede.
- Walker, D.F., 1992, Methodological issues in curriculum research, In Jackson, P. (Ed.), *Handbook of research on curriculum* (pp. 98-118), Macmillan, New York.
- Walker, D. and Bresler, L., 1993, *Development research: Definitions, methods, and criteria*, Paper presented at AERA meeting, April 12-16, Atlanta.
- Yin, R.K., 1994, *Case study research: Design and methods* (2nd edition), Sage, Beverley Hills, CA.